

PERISTENUS DIGONEUTIS
(HYMENOPTERA: BRACONIDAE), A PARASITE OF
***LYGUS LINEOLARIS* (HEMIPTERA: MIRIDAE) IN**
NORTHEASTERN UNITED STATES ALFALFA,
AND THE NEED FOR RESEARCH ON OTHER CROPS¹

W. H. Day,² A. T. Eaton,³ R. F. Romig,⁴ K. J. Tilmon,⁵ M. Mayer,⁶ and T. Dorsey⁶

ABSTRACT: The tarnished plant bug (TPB), *Lygus lineolaris* (Palisot), damages a wide variety of important crops in North America. *Peristenus digoneutis* Loan, a European parasite established to provide biological control of this plant bug, has reduced TPB numbers in alfalfa for ten years. Damage to apple fruit in New Hampshire during the same time period has been reduced by 63%, and it appears that biological control is responsible for this decrease. Moderate to high parasitism rates by *P. digoneutis* have also been observed in strawberries, vetch, red clover, and weeds. *P. digoneutis* is dispersing on its own, and has been found in 62 counties in eight states, and in Canada. Additional research is needed on the parasitism of *L. lineolaris* on apples and other crops, and on movement of the parasite into new areas.

KEY WORDS: *Peristenus digoneutis*, Hymenoptera, Braconidae, *Lygus lineolaris*, Hemiptera, Miridae, alfalfa.

Lygus lineolaris (Palisot), the tarnished plant bug (TPB) (Hemiptera: Miridae), is a moderate to serious pest of a wide variety of crops—fruits (Bobb 1970, Guest 1999, Mailloux and Bostanian 1988, Weires et al. 1985), vegetables (Boivin et al. 1991, Guest 1999, Hagle 1978), crops grown for seed (Gupta et al. 1980, Scott et al. 1966, Wise and Lamb 1998), tree seedlings (Schowalter and Stein 1987), and cotton (Scott et al. 1985). Large numbers of TPB often are produced in forage crops (alfalfa and red clover), but usually they are thought to only damage these crops when they are grown for seed. However, when alfalfa or clover is harvested for hay, large numbers of adult TPB may fly into high-value crops, where they may cause serious yield and quality losses. For example, apples are damaged when TPB adults puncture the small fruit, which later become distorted at the feeding site as the fruit grows. Many affected apples will be so blemished or misshapen that they cannot be sold, or bring very low prices. Peaches, strawberries, raspberries and blackberries are similarly distorted, and fruit yield / quantity is also reduced.

Early research (Day 1987) showed that parasitism of the TPB, a native species, in alfalfa by native parasites was very low. Consequently, parasites of the European tarnished plant bug (*L. rugulipennis*) were collected by the USDA

¹ Received on July 16, 2002. Accepted December 21, 2003.

² USDA-BIRL, 501 S. Chapel Street, Newark, DE 19713. E-mail: wday@biir.ars.usda.gov.

³ Plant Biology Department, University of New Hampshire, Durham, NH 03824.

⁴ West Chester State University. Present address: 13 Linda Lane, Fleetwood, PA 19522.

⁵ Entomology Department, Cornell University, Ithaca, NY 14853.

⁶ New Jersey Dept. of Agriculture, Trenton, NJ 08625.

European Biological Control Lab, and these were released by WHD at two locations in NJ and one in DE. The plan was to establish one or more parasites in alfalfa, because this is a common crop in the northeast U.S. (10 million acres), so it could serve as a reservoir for the parasite. Alfalfa is especially suitable because it is not frequently sprayed with insecticides (due to the successful biological control of the alfalfa weevil, blotch leafminer, and pea aphid initiated by the USDA). Establishment of an effective parasite could reduce TPB damage indirectly (via reduction in the number of TPB adults leaving alfalfa for susceptible crops) or directly (by reducing TPB numbers in fruit and vegetable crops).

Peristenus digoneutis Loan, a small parasite (Hymenoptera: Braconidae) of TPB nymphs, was established in northwestern New Jersey by the first author in 1984 (Day et al. 1990). It has two generations per year, which attack the two principal generations of the TPB, and was soon killing 50 percent of nymphs. By 1993 this parasite had been detected in nine counties, in parts of four states (Fig. 1, 1993 line). And, in our long-term alfalfa monitoring fields in northwestern New Jersey, the parasite had reduced TPB numbers by 65% (Day 1996).

Peristenus digoneutis has continued to disperse in all directions but south, where it is likely limited by summer temperatures (Day et al. 2000). *P. digoneutis* has now been detected in 62 counties in 8 states, and in Canada (Fig. 1). The objective of this paper is to present data on TPB damage to apples during a 20-year period, which it is hoped will stimulate research on other crops damaged by the TPB, at locations where the parasite is present.

METHODS

Tarnished plant bug nymphs were collected in alfalfa fields, using a sweep net, near Blairstown, New Jersey (lat. 41°00' N, long. 75°00' W, elevation 160-290 m). Three fields were sampled weekly with a sweep net from early May through July, when this mirid is most abundant, and biweekly from August to October. The data in Figure 2 show the average numbers of TPB nymphs each year: each number is an average of the maximum (peak) number sampled during the first and second generations (which usually occur in late June and late July); each number per generation is an average of three fields. Data are presented for 19 years. Additional details on the sampling methods are in Day (1996).

Each year, apples were examined at harvest, in 15-28 commercial orchards (avg. 23) across New Hampshire. An average of 11,500 apples (500 per orchard) were checked for defects per year, and the percentage damaged by the TPB was recorded. The average injury over all orchards each year, for 20 years, is presented in Figure 3. The pre- and post-biocontrol means for both TPB numbers and apple damage were compared by an analysis of variance, using years as replicates. The percentage damaged apples data were normalized using the arcsine transformation (Snedecor 1956) before the data were analyzed.



Figure 1. The known distribution of *Peristennus digoneutis* in the northeastern United States and southeastern Canada as of March 2003. This map is from Day et al. 2000, updated by an additional 13 county records obtained in 2000–2002 (locations and dates are in Table 1). The Canadian records are from Broadbent et al. 1999. The numbers in the counties indicate where and when the first recovery was made. In most cases, this was the first attempt to detect this species, so it had arrived earlier. The heavy lines depict the probable dispersion of the parasite by 1993, 1996, 1999, and 2002.

RESULTS AND DISCUSSION

Previous research (Day 1996) documented the large increase in parasitism of TPB nymphs caused by *P. digoneutis* from 1985 through 1992, and the rapid decrease in TPB numbers from 1990–1993. Figure 2 shows that the TPB has remained at low levels during the six years (1994–1999) since then. The overall result is a population reduction of 65%, for eight consecutive years.

Table 1. New country detection records* for *P. digoneutis*, 2000-2002

<u>State</u>	<u>County</u>	<u>Nearest town</u>	<u>Date</u>	<u>Author</u>
NJ	Mercer	Pennington	7/29/02	Day
	Gloucester	Aura	7/18/02	Mayer & Dorsey
NY	Cayuga	Scipio Center	6/26/02	Romig
	Chenango	Norwich	6/24/02	Romig
	Cortland	Marathon	6/27/02	Romig
	Madison	Nelson	6/25/02	Romig
	Onondaga	Pompey	6/25/02	Romig
	Seneca	Fayette	6/26/02	Romig
	Tompkins	Lansing	6/26/02	Romig
PA	Northumberland	Elysburg	7/27/00	Romig
	Lycoming	Calvert	7/23/01	Romig
	Potter	Brookland	7/31/01	Romig
	Tioga	Wellsboro	8/01/01	Romig

* Females were reared from field-collected nymphs. Females are positive evidence of an established parasite population (females can only be produced by mated female parents, so both sexes were present).

During the same time period, damage to apples by the TPB decreased by a similar amount (63%) for 10 years (Fig. 3). Although no concurrent TPB counts had been made in these orchards, the striking similarity between Figs. 2 and 3 suggests that a general decrease in TPB numbers occurred. The parasite was numerous enough to be detected the first year it was looked for (1996, Fig. 1; Day et al. 2000), so it must have been present in New Hampshire for several years. In addition, the high parasitism rates observed in alfalfa (Day 1996), and in weeds and cover crops (Tilmon 2001, RFR unpubl.), indicate that TPB numbers should be reduced over large areas—so fewer TPB adults should be available to fly into apple orchards to feed on (and injure) the young apples.

Field samples in the northeastern states by the authors have found *P. digoneutis* parasitizing significant numbers (30% or more) of TPB nymphs in alfalfa, vetch, strawberries, and weeds (chickweed, fleabane) (Tilmon 2001, and WHD unpubl.). Parasitism levels are now high enough in several crops and weeds that research on the value of biological control can be conducted in many northeastern locations. Such studies are needed on strawberries, apples, peaches, raspberries, beans, and other crops. If anyone is interested in starting cooperative or independent research, contact the first author.

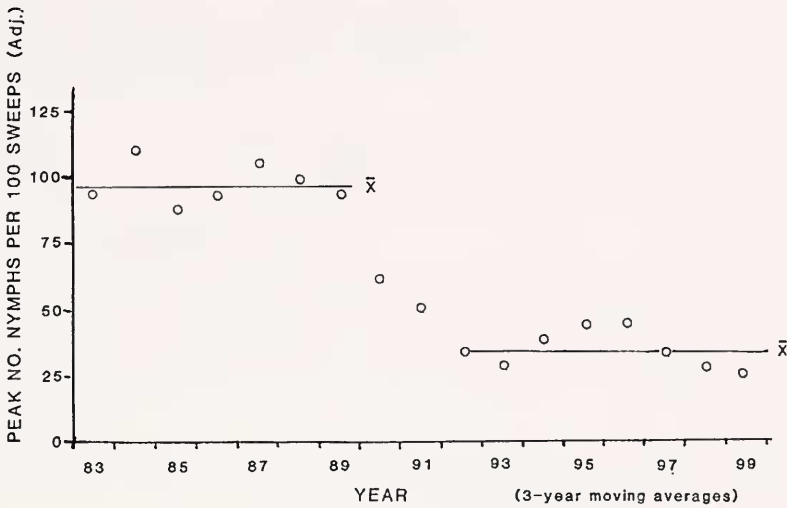


Figure 2. The abundance of tarnished plant bug nymphs in alfalfa, in northwest New Jersey, 1983-1999. The two averages ("before biocontrol" and "after biocontrol") are statistically different ($F = 267$; $df = 7,1$; $P < 0.001$).

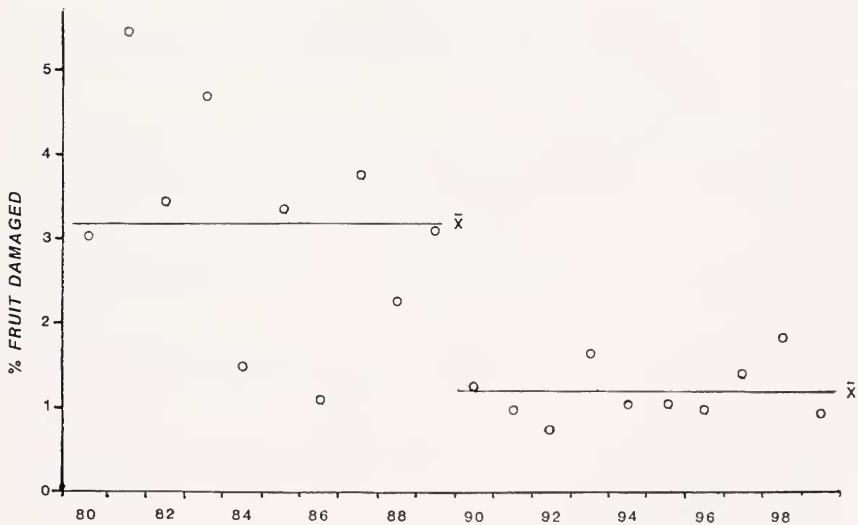


Figure 3. The incidence of tarnished plant bug injury to apples in New Hampshire, 1980-1999. The "before" and "after" averages are statistically different ($F = 26.7$; $df = 9,1$; $P < 0.001$).

ACKNOWLEDGMENTS

We thank R. W. Fuester and the two reviewers for suggestions to improve the manuscript, and we thank B. R. Holmes for typing. We also appreciate the cooperation of the many growers who allowed us to sample insects and fruit on their farms.

LITERATURE CITED

- Bobb, M. L.** 1970. Reduction of cat-facing injury to peaches. *Journal of Economic Entomology* 63:1026-1027.
- Boivin, G., J. LeBlanc, and J. A. Adams.** 1991. Spatial dispersion and sequential sampling plan for the tarnished plant bug on celery. *Journal of Economic Entomology* 84: 158-164.
- Broadbent, A. B., H. Goulet, J. W. Whistlecraft, S. LaChance, and P. G. Mason.** 1999. First Canadian record of 3 parasitoid species (Hymenoptera: Braconidae: Euphorinae) of the tarnished plant bug, *Lygus lineolaris* (Hemiptera: Miridae). *Proceedings of the Entomological Society of Ontario* 130:109-111.
- Day, W. H.** 1987. Biological control efforts against *Lygus* and *Adelphocoris* spp. infesting alfalfa in the United States, with notes on other associated mirid species. In: R. C. Hedlund and H. M. Graham (Editors). *Economic Importance and Biological Control of Lygus and Adelphocoris in North America*. USDA-ARS 64. pp. 20-39.
- Day, W. H.** 1996. An evaluation of biological control of the tarnished plant bug, *Lygus lineolaris* (Hemiptera: Miridae), in alfalfa by the introduced parasite *Peristenus digoneutis* (Hymenoptera: Braconidae). *Environmental Entomology* 25:512-518.
- Day, W. H., R. C. Hedlund, L. B. Saunders, and D. Coutinot.** 1990. Establishment of *Peristenus digoneutis* (Hymenoptera: Braconidae), a parasite of the tarnished plant bug (Hemiptera: Miridae), in the United States. *Environmental Entomology* 19:1528-1533.
- Day, W. H., K. J. Tilmon, R. F. Romig, A. T. Eaton, and K. D. Murray.** 2000. Recent range expansions of *Peristenus digoneutis*, a parasite of the tarnished plant bug, and high temperatures limiting its geographic distribution in North America. *Journal of the New York Entomological Society* 108:326-331.
- Guest, J.** 1999. Tarnished plant bug is by far Vermont's most important vegetable and berry pest. pp. 51 In: K. A. Stoner (Editor). *Alternatives to insecticides for managing vegetable insects*. National Resource, Agriculture, and Engineering Service. Cooperative Extension. Cornell University. Ithaca, New York, U.S.A. 76 pp.
- Gupta, R. K., G. Tamaki, and C. A. Johansen.** 1980. *Lygus* bug damage, predator-prey interaction, and pest management implications on alfalfa grown for seed. Washington State University. Technical Bulletin 92. 18 pp.
- Hagel, G. T.** 1978. *Lygus* spp. damage to beans by reducing yields, seed pitting, and control by varietal resistance and chemical sprays. *Journal of Economic Entomology* 71:613-615.
- Maillox, G. E. and N. J. Bostanian.** 1988. Economic injury level model for tarnished plant bug in strawberry fields. *Environmental Entomology* 17:581-586.
- Schowalter, T. D. and J. D. Stein.** 1987. Influence of Douglas-fir seedling proximity to insect population sources on susceptibility to *Lygus hesperus* in a forest nursery in western Oregon. *Environmental Entomology* 16:984-986.
- Scott, D. R., A. J. Walz, and H. C. Manis.** 1966. The effect of *Lygus* sp. on carrot seed production in Idaho. University of Idaho. Agricultural Research Bulletin 64. 12 pp.
- Scott, W. P., J. W. Smith, and G. L. Snodgrass.** 1985. The tarnished plant bug (Hemiptera: Miridae): A key pest of cotton in the Mississippi Delta. *Proceedings of the Beltwide Cotton Producers Research Conference*. pp. 164-167.

-
- Snedecor, G. W.** 1956. Statistical Methods. Iowa State College Press. Ames, Iowa, U.S.A. 534 pp.
- Tilmon, K. J.** 2001. Biological control of *Lygus lineolaris* (Hemiptera: Miridae), a generalist herbivore, by native and introduced *Peristenus* (Hemiptera: Braconidae). Ph.D. Thesis, Cornell University. Ithaca, New York, U.S.A. 125 pp.
- Weires, R. W., J. R. Vankirk, W. D. Gerling, and F. M. McNicholas.** 1985. Economic losses from the tarnished plant bug on apple in eastern New York. *Journal of Agricultural Entomology* 2:256-263.
- Wise, I. L. and R. J. Lamb.** 1998. Economic threshold for plant bugs, *Lygus* spp., in canola. *Canadian Entomologist* 130:825-836.